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The Composition of Paper and Paperboards Manufactured in 1939

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CONTENTS

	Page
Introduction	1
The use of fibers in paper	3
Early methods and materials	3
The wood-pulp era	4
Composition of paper and paperboards in 1939	8
Losses of materials in paper making	8
Residual constituents of paper in 1939	10
Conversion factors	16
How fiber requirements have been met at home	17
By expansion of the sulfate industry	17
By utilization of waste paper	18
By economies in pulping processes	20
Dependence upon foreign fiber	20
Outlook for the future	23

INTRODUCTION

The principal purpose of this circular is to show the quantities of various materials composing the principal papers and paperboards made in the United States in 1939. That year was chosen for two reasons: First, because it was the last in which the normal operations of the paper industry were undisturbed by the war in Europe; second, because it is a decennial year, in which special information essential to the project was made available by the Census of Manufactures.

Somewhat similar summaries have been made in earlier years, but these were based on less complete information, and the estimates of composition were applied directly to the six major classes of paper commonly recognized; namely, newsprint, book, fine, boards, wrapping, and all other (miscellaneous). In the present instance the estimates of materials included are applied for the first time to the 86 subclasses of papers in which the Bureau of the Census reports paper production.

Such detailed consideration of the composition of papers afforded a much more accurate distribution of the materials used. The data have been combined (tables 7 to 11) into 18 classes of paper and boards. For comparison with other years, they have also been compiled in the familiar six major classes, the relation of which to the subclasses is as follows:

Major classes	*Subclasses*	*Major classes*	*Subclasses*
Cultural group:		Utility group:	
Newsprint	2	Boards	22
Book	7	Wrapping	21
Fine	5	Miscellaneous	29
Total	14	Total	72
		Grand total	86

Actually there are many additional varieties of the subclasses, each adapted by means of the component materials or the processing to the exacting needs of some specific use. It is observable that the most numerous advances in specialization have been made in the utility group.

The fundamental data for this analysis are the quantities of each kind of material used in paper manufacture in 1939, as reported to the Bureau of the Census. Nearly one-eighth of the total tonnage of materials used does not appear in the finished paper, because of losses in manufacture. Estimates were made of the loss of each material and the residual quantity. These data were submitted to a number of authorities for criticism. Very helpful comments, not only on percentage losses of important materials in manufacture but also on their percentage distribution in various papers, were received from the following manufacturers:

Alton Box Board Co., Alton, Ill.; American Writing Paper Corp., Holyoke, Mass.; Brunswick Pulp and Paper Co., Brunswick, Ga.; The Champion Paper and Fibre Co., Canton, N. C.; Container Corporation of America, Chicago, Ill.; Crossett Paper Mills, Crosset, Ark.; Finch, Pruyn and Co., Inc., Glens Falls, N. Y.; The Flintkote Co., East Rutherford, N. J.; Hammermill Paper Co., Erie, Pa.; Hawley Pulp and Paper Co., Oregon City, Oreg.; International Paper Co., New York, N. Y.; Johns-Manville Corp., New York, N. Y.; Pacific Paper-Board Co., Longview, Wash.; Kieckhefer Container Co., Delaire, N. J.; Kieffer Paper Mills, Ewing, Ind.; Pejepscot Paper Co., Brunswick, Maine; Robert Gair Co., Inc., New York, N. Y.; and Weyerhaeuser Timber Co., Longview, Wash.

Most helpful information both on losses of materials and their distribution into some of the papers was received from R. S. Kellogg and W. G. MacNaughton, of the News Print Service Bureau, New York, N. Y., and from Charles W. Boyce, Office of Production Management, Washington, D. C.

Especial appreciation is due Norman S. Meese, of the United States Tariff Commission, who drew on the records of the Commission and also on his own extended observations of technical operations in the mills in giving advice and practical assistance concerning some of the more important estimates.

Table 4, showing estimated losses of materials used in paper manufacture, and also table 5, showing their valuation, are believed to be unique. Their accuracy in detail may be subject to question; all that is claimed is that they are the resultant of estimates by some of the foremost authorities of the paper industry and a painstaking effort to reconcile these opinions with the best factual material available.

Second in importance in this circular are the conversion factors showing the statistical relationship of the six classes of paper to the component wood pulps, and also of the wood pulps to pulpwood, based on average practice in the United States. (See tables 12, 13, and 14.) These are working tools for forest economists and others who deal with such relationships.

The paper industry today is in a state of flux unparalleled at any previous time. The figures shown here—those for 1939—had changed to an unknown extent by 1942. Under the stress of war conditions these disparities may increase. It is believed, however, that this statement of the furnish of paper as of 1939 may prove useful for some years as an anchor point for wartime calculations.

THE USE OF FIBERS IN PAPER

Early Methods and Materials

When paper was invented in China nearly 2,000 years ago, it was nothing more than a thin sheet of vegetable fibers closely matted and bonded together. That is what it remains today. Ninety-five percent of the tonnage of paper now manufactured in the United States consists solely of vegetable fibers. The numerous discoveries and inventions of more than 18 centuries—and particularly of the last century—have revolutionized the techniques of paper making, but not the essential nature of paper itself.

The earliest papers were intended only for writing, and were reserved for such weighty purposes as records of State and religious and historical documents. The quantity used was obviously quite small. With the Renaissance came a growing demand for both written and printed matter. The paper of those times was scarce and costly. Until the industrial revolution all of it was made by hand—skilled workmen laboriously rolling out one sheet at a time. The introduction of power-driven machinery, however, permitted the rapid production of paper in continuous webs and furnished a more plentiful supply of book and fine. Such processes made newsprint possible, as well as greater supplies of utility papers.

For more than 1,800 years the principal source of the vegetable fibers was rags of cotton and linen. Today our finest papers are 100 percent linen. The Egyptians used papyrus, and the Japanese still make some paper from the inner bark of the mulberry tree. The supply of desirable fibers appears to have been increasingly inadequate for the needs of the industry right up to the wood-pulp era. As recently as 1939, 50,000 tons of rags were imported to augment the domestic supply. But the increased use of paper and the increased capacity of the mills to make it surpassed all possibility of obtaining the needed quantities of raw materials from rags alone and stimulated the search for new fibers.

The world has been ransacked for other paper-making materials. Over 400 fibers have been tested or used for paper, and all but a very small group have been discarded, either because of the lack of desirable qualities or because they could not be had in commercial quantities and at suitable prices. Animal fibers, such as wool and silk, are not well adapted for any general paper use. In the lack of better fibers during Civil War days, straw came in as a not-very-satisfactory makeshift. It was used for part of the newsprint, but more extensively for wrapping paper. In 1879 it constituted nearly 40 percent of the paper-making materials used. At that time, however, the quantity of paper made was still relatively small and per capita consumption was less than one-tenth what it is now. It was not until the introduction of improved pulps consisting of wood fiber that a sound foundation was laid for the giant paper industry of the twentieth century.

The Wood-Pulp Era

The shift from vegetable fibers of the annual crops to the vegetable fibers of wood brought many considerable advantages. An acre of straw could hardly supply at one cutting more than a ton of air-dry fiber for the use of the paper maker. An acre of cordwood, however, might readily supply 10 tons of equally good or better fiber at one cutting—the accumulated growth of several decades. Moreover, the fiber of wood is packed into very condensed form, a distinct advantage in handling, shipping, and storing. And the available volume of wood was seemingly limitless. Whereas in 1879 less than 4 percent of the material used in paper was wood pulp (ground wood and soda pulp, used only as filler), after the strong sulfite and sulfate pulps became available the use of wood fiber steadily increased. The peak came in 1909, when new wood fiber constituted 61 percent of the tonnage of materials consumed. As to quality, in modern practice the best chemical wood pulps are able to meet all but very exacting needs in paper manufacture.

Supplied for the first time with ample raw material, the paper industry grew at an amazing rate, as is illustrated for the six broad classes of paper in table 1. In the 60 years between 1879 and 1939, population was multiplied 2.7 times, but the consumption of paper was multiplied 35 times. Paper production increased thirtyfold. The most spectacular increase was that in paperboards, which, although the least of all in 1879, was multiplied 300 times during the 60-year period and since 1919 has been the leading class of paper. More than four-fifths of the paper made in 1939 was of the utility classes (boards, wrapping, and miscellaneous).

The packaging of motor-borne freight in cartons and bags of size convenient for handling in retail trade has both resulted from, and contributed to, the expansion of manufactures and agriculture and the wider distribution of their products to markets made available by motortrucks. More and more has paperboard supplanted wood.

In hundreds of other lines paper has taken the place of wood, glass, and metal. Wood pulps, too—principally bleached sulfite—are used for many products other than paper, such as rayon, transparent sheeting, explosives, photographic films, lacquers, and plastics. In these fields they compete with the more expensive cotton linters. But in 1939 paper and paperboards took 8,650,000 tons, or 97.4 of the wood pulp consumed in the United States, leaving 2.6 percent for these other industries. Rayon took only 145,000 tons, or 1.6 percent. At no period has the paper industry had a rival as a consumer of wood fiber.

TABLE 1.—*Paper produced annually, by kinds, in decennial years, and paper consumption*

[Thousand tons; i. e., 000 omitted]

Kind	1879	1889	1899	1909	1919	1929	1939
Cultural:							
Newsprint	[1] 80	196	569	1,176	1,324	1,409	954
Book	[1] 69	151	323	695	961	1,498	1,535
Fine	33	69	113	198	325	607	595
Total	182	416	1,005	2,069	2,610	3,514	3,084
Utility:							
Boards	20	150	394	883	1,867	4,451	6,105
Wrapping	134	277	536	763	859	1,606	2,239
All other	116	92	233	502	763	1,569	2,082
Total	270	519	1,163	2,148	3,489	7,626	10,426
Grand total	452	935	2,168	4,217	6,099	11,140	13,510
Total consumption [2]	457	1,121	2,158	4,224	6,493	13,351	15,775
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Per capita	18	36	58	93	124	220	241

[1] Estimated.

[2] The excess of consumption over production is due principally to the heavy imports of newsprint, of which 3,549 thousand tons were consumed in 1939.

The increase in the total tonnage of materials used in the decade 1930–39 is fairly proportionate to that of paper, which increased from 11 million tons in 1929 to 13½ million tons in 1939. This increase, however, was not shared uniformly by the materials used (table 2).

TABLE 2.—*Materials used in manufacture of paper and paperboards, 1929 and 1939* [1]

Material	Consumption		Change plus or minus
	1929	1939	
New wood pulp:	*Tons*	*Tons*	*Percent*
Mechanical	1,865,012	1,749,118	−6.2
Sulfite	2,551,034	2,912,704	+14.2
Soda	520,308	515,650	−.9
Sulfate	1,312,483	3,354,338	+155.7
Semichemical	40,481	118,613	+193.0
Total	[2] 6,289,318	8,650,423	+37.5
Other fibers:			
Waste paper	3,841,942	4,366,257	+13.6
Straw	575,263	512,993	−10.8
Rags	739,422	468,287	−36.7
Manila stock, etc	128,800	64,149	−50.2
All other (cotton, esparto, etc.)	50,000	115,173	
Total	5,335,427	5,526,859	+3.6
Nonfibrous:			
Clay	470,528	427,481	−9.2
Rosin	38,390	35,915	−6.4
Rosin size	99,443	94,325	−5.2
Casein	18,451	17,587	−4.7
All other	250,000	571,115	
Total	876,812	1,146,423	
Grand total	12,501,557	15,323,705	

[1] New wood-pulp figures and those for "other" fibrous and nonfibrous materials for 1929 are Forest Service estimates, of which the "other" are probably too conservative. Other figures are based on decennial reports of the Census of Manufactures. The materials used in paper making are conveniently classified in three groups, first the new wood pulps, second, the other fibrous materials, such as waste paper, straw and rags, and third, the nonfibrous materials, such as clay, rosin, and casein, also talc, glue, starch, wax, dye, and certain chemicals which are applied to various papers. Quantities in tons of 2,000 pounds.

[2] Screenings are included in corresponding kinds of new pulp.

New wood pulp increased 37.5 percent as a class, but ground wood actually decreased owing to the decrease in newsprint production. The outstanding change between 1929 and 1939 was the enormous growth in the use of sulfate pulps, amounting to 155.7 percent. Other fibrous materials increased as a group by only 3.6 percent. Most of them show substantial decreases with the exception of waste paper, which increased 13.6 percent. In the nonfibrous group all materials for which record figures exist showed definite decreases, for which no explanation is obvious. As a whole the class probably decreased, possibly by as much as 8 percent.

The increased requirement for wood fiber was due, not only to the increased tonnage of paper manufactured, but to the increased percentages of wood pulp appearing in that tonnage. Not only new pulp but reused pulp made from waste paper is utilized. The percent of wood pulp from each of these sources has increased to a striking degree since 1879 (fig. 1).

A still more convincing index of the increasing demand for wood fiber is the advance in the rate of per capita consumption of paper. In 1940 the average individual use in the United States was four times as great as at the beginning of the century. That fact is a tribute to the skill of paper manufacturers, who have devised so many new uses for paper and have been able to market their wares at prices within ready reach of almost all American families. For convenience of reference, table 3 shows in detail the increase in per capita consumption of each principal class of paper.

The papers of the cultural group apparently reached their peak in rate of consumption as of 1929. The opinion would seem to be justified that little or no further increase in the per capita use of cultural papers may be expected. The rate of use of the utility papers, however, has apparently not yet reached a peak. The averages for all three were still increasing in 1940, and all are commodities susceptible of greater use.

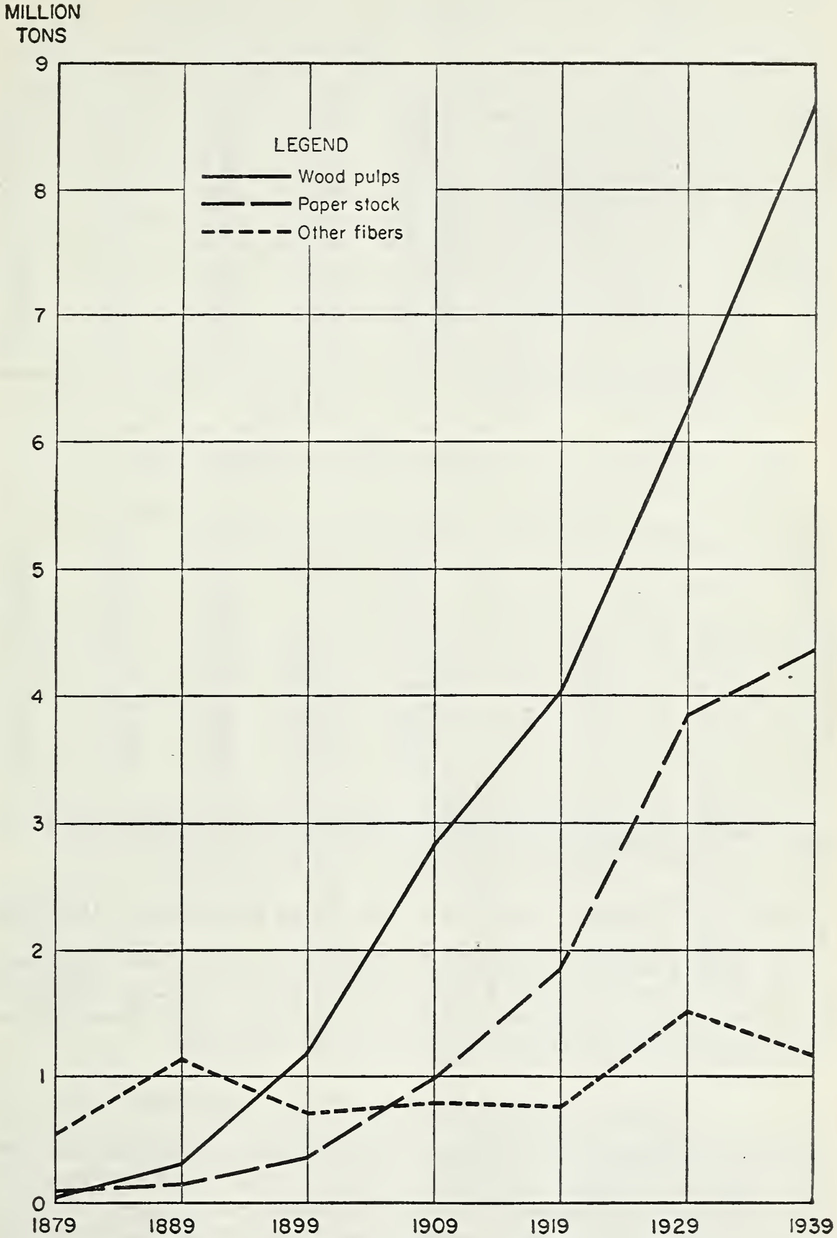

FIGURE 1.—Tonnage of principal fibers used in paper making in decennial years, 1879–1939.

TABLE 3.—*Per capita consumption of papers in specified years* [1]

Year	Population July 1	Cultural papers				Utility papers				All papers
		Newsprint	Book	Fine	Total	Boards	Wrapping	Miscellaneous	Total	
	Thousands	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1899	74, 799	15. 2	8. 4	3. 0	26. 6	10. 6	14. 3	6. 2	31. 1	57. 7
1909	90, 691	25. 6	15. 2	4. 3	45. 1	19. 5	16. 8	11. 8	48. 1	93. 2
1919	105, 003	36. 0	16. 0	5. 8	57. 8	37. 0	15. 6	13. 2	65. 8	123. 6
1924	113, 202	48. 4	19. 0	7. 0	74. 4	50. 2	21. 9	17. 7	89. 8	164. 2
1929	121, 526	*62. 2*	24. 2	*9. 8*	*96. 2*	72. 4	26. 1	24. 5	123. 0	219. 2
1930	123, 091	57. 9	22. 3	9. 2	89. 4	65. 2	25. 3	20. 3	110. 8	200. 2
1931	124, 113	52. 3	19. 2	7. 7	79. 2	61. 2	22. 3	18. 0	101. 5	180. 7
1932	124, 974	45. 4	15. 0	6. 7	67. 1	52. 7	19. 7	14. 2	86. 6	153. 7
1933	125, 770	42. 8	17. 0	7. 5	67. 3	64. 5	22. 6	18. 0	105. 1	172. 4
1934	126, 626	48. 3	16. 5	6. 5	71. 3	63. 7	21. 0	18. 4	103. 1	174. 4
1935	127, 521	51. 8	20. 0	7. 7	79. 5	73. 0	25. 3	19. 6	117. 9	197. 4
1936	128, 429	56. 8	22. 3	9. 2	88. 3	84. 3	29. 2	23. 6	137. 1	225. 4
1937	129, 257	59. 3	23. 4	8. 7	91. 4	88. 9	31. 5	26. 6	147. 0	238. 4
1938	130, 215	53. 1	20. 4	7. 2	80. 7	77. 3	28. 4	24. 6	130. 3	211. 0
1939	130, 878	54. 2	23. 3	8. 8	86. 3	92. 0	33. 8	29. 0	154. 8	241. 1
1940	131, 949	56. 5	*24. 5*	8. 3	89. 3	*93. 8*	*36. 4*	*30. 5*	*160. 7*	*250. 0*

[1] As computed by the Division of Forest Economics, Forest Service, based on production, imports, and exports. The column for newsprint is as computed by the News Print Service Bureau and includes allowances for the changes of mill stocks and publishers stocks. Italic figures indicate peak quantities.

COMPOSITION OF PAPER AND PAPERBOARDS IN 1939

The total quantity of the paper-making materials used in 1939 was 15,323,705 tons, as reported by the Bureau of the Census. Of this total, 56.4 percent was new pulp, 36.1 percent was other fibrous materials, and 7.5 percent consisted of nonfibrous materials.

LOSSES OF MATERIALS IN PAPER MAKING

The manufacture of 13,509,642 tons of paper and boards in 1939 from 15,323,705 tons of materials indicates that 1,814,063 tons, or 11.8 percent, of the materials was lost in the processes of paper making. This aggregate loss is easily ascertainable, but its break-down into specific materials and classes of paper has not previously been achieved with any degree of accuracy.

In order to adjust the net weight of various materials for allocation to finished papers, as shown in subsequent tables, it was necessary to determine the widely varying rates of loss in the several materials. As stated in the foreword, these rates of loss were based largely on information received from 18 prominent manufacturers and from experts who have observed for many years the technical operations in paper mills, and who are thus in a position to approximate not only the losses in process, but in some instances the average furnish of papers, or the proportion of the various materials used in each.

According to these evidences about four-tenths of the aggregate loss in manufacture consisted merely of surplus water in the raw materials which was excluded from the finished paper (table 4). New pulps have the lowest relative losses in process, averaging 6.0 percent. "Other fibers" lose at a greater rate, averaging 14.4 percent. This group, as a whole, accounts for well toward half of the aggregate. The highest rates of loss appear in the third group (nonfibrous materials), averaging 43.1 percent. These materials accordingly appear only as very small components of the tonnage of finished papers.

TABLE 4.—*Estimated losses of materials used in paper manufacture, 1939*

Material	Materials consumed [1]		Reduction of water or other liquid [2]		Losses of fiber or other solid [3]		Total losses in manufacture		Quantities retained in paper [4]
	Percent	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Tons*
New wood pulp:									
Mechanical	11.4	1,749,118	4.0	69,965	1.4	24,689	5.4	94,654	1,654,464
Sulfite	19.0	2,912,704	3.8	110,683	1.2	34,971	5.0	145,654	2,767,050
Soda	3.4	515,650	3.7	19,079	1.1	5,658	4.8	24,737	490,913
Sulfate	21.8	3,354,338	4.8	161,008	2.7	90,567	7.5	251,575	3,102,763
Semichemical	.8	118,613	3.9	4,626	1.7	2,016	5.6	6,642	111,971
Total	56.4	8,650,423	4.2	365,361	1.8	157,901	6.0	523,262	8,127,161
Other fibers: [5]									
Waste paper	28.5	4,366,257	4.5	196,482	8.0	348,804	12.5	545,286	3,820,971
Straw	3.3	512,993	4.5	23,085	23.5	120,553	28.0	143,638	369,355
Rags	3.1	468,287	4.5	21,073	13.7	64,220	18.2	85,293	382,994
Manila stock, etc	.4	64,149	4.5	2,887	6.6	4,262	11.1	7,149	57,000
All other	.8	115,173	4.5	5,183	8.5	9,789	13.0	14,972	100,201
Total	36.1	5,526,859	4.5	248,710	9.9	547,628	14.4	796,338	4,730,521
Nonfibrous:									
Clay	2.8	427,481	6.0	25,649	23.1	98,838	29.1	124,487	302,994
Rosin	.2	35,915			10.0	3,592	10.0	3,592	32,323
Rosin size	6.2	94,325	15.0	14,149	10.0	9,432	25.0	23,581	70,744
Casein	.1	17,587	2.0	352	13.0	2,286	15.0	2,638	14,949
All other	3.7	571,115	10.0	57,111	49.6	283,054	59.6	340,165	230,950
Total	7.5	1,146,423	8.5	97,261	34.6	397,202	43.1	494,463	651,960
Grand total	100.0	15,323,705	4.6	711,332	7.2	1,102,731	11.8	1,814,063	13,509,642

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[1] Quantities reported by the Census of Manufactures, 1939.

[2] It is commonly stated that new pulps contain 10 percent water and finished paper about 4 percent, indicating a loss of 6 percent moisture in paper manufacture. The first figure may not be a correct average for moisture content of all pulps. Moreover, it is stated by some experts and manufacturers that the moisture content of various papers may be as much as 5 or even 7 percent, indicating losses of 5 to 3 percent. The present compilation, showing an average water loss of 4.2 percent for new wood pulp is in harmony with the latter figures.

[3] Forest Service estimates based on statements from 18 manufacturers, averages derived from Census data, and advices of paper experts.

[4] Quantity of each material remaining in finished paper. The data are for paper and boards manufactured in 1939.

[5] Losses in the case of other fibers includes cooking, washing, and screening losses as well as those in the manufacture of paper from pulp.

The total value of the 15 million tons of materials used in paper making in 1939 was $398,000,000. Of this total, the cost of the new wood pulps (table 5) was 70 percent and of waste paper 14 percent, or $334,000,000 for all wood-fiber materials. The estimated cost of the materials lost in manufacture is more than $45,000,000, of which 35 percent was in new pulps and 16 percent in reused paper. Thus a little more than half the cost of all the lost materials applies to the wood fibers, new and old. Nevertheless, considering the tonnages involved, the loss in new pulps appears very reasonable in contrast with those of the nonfibrous group.

Table 5.—*Value of total materials used and of those lost in paper manufacture, 1939* [1]

Material	Total materials used [2]			Estimated loss in manufacture [3]	
	Quantity	Value	Value per ton	Quantity	Value
	Tons	*Dollars*	*Dollars*	*Tons*	*Dollars*
New wood pulp:					
Mechanical	1,749,118	34,445,044	19.69	94,654	1,863,737
Sulfite	2,912.704	131,719,989	45.22	145,654	6,586,474
Soda	515,650	22,211,988	43.08	24,737	1,065,670
Sulfate	3,354,338	86,505,597	25.79	251,575	6,488,119
Semichemical	118,613	1,636,226	13.79	6,642	91,593
Total	8,650,423	276,518,844	31.97	523,262	16,095,593
Other fibers:					
Waste paper	4,366,257	57,293,159	13.12	545,286	7,154,152
Straw	512,993	3,400,220	6.63	143,638	952.320
Rags	468,287	14,808,348	31.62	85,293	2,696,965
Manila stock, etc	64,149	2,232,647	34.80	7,149	248,785
All other	115,173	3,186.458	27.67	14,972	414,275
Total	5,526,859	80,920,832	14.64	796,338	11,466,497
Nonfibrous:					
Clay	427,481	7,480,640	17.50	124,487	2,178,523
Rosin	35,915	1,940,926	54.04	3,592	194.112
Rosin size	94,325	4,980,259	52.80	23,581	1,245,077
Casein	17,587	3,244,243	184.47	2,638	486,632
All other	571,115	22,928,742	40.15	340,165	13,657,625
Total	1,146,423	40,574,810	35.39	494,463	17,761,969
Grand total	15,323,705	398,014,486	25.97	1,814,063	45,324,059

[1] In tons of 2,000 pounds.

[2] As reported by the Census of Manufactures, 1939. The value of the paper and paper boards produced in 1939 was $933,015,664.

[3] Forest Service estimates.

Residual Constituents of Paper in 1939

Subtracting the computed losses in paper making from the reported totals of materials consumed gives the residuals shown in the last column of table 4, the total of which equals the tonnage of paper produced in 1939. In table 6, these residuals are distributed into the six chief classes of quality and utility papers. In tables 7 to 10 they are further broken down into the 18 subclasses already mentioned.

Tables 6 to 10 need no further explanation or comment, save that they constitute a unique record of the approximate furnish of American papers in the year 1939.

TABLE 6.—*Composition of principal papers and paperboards manufactured in 1939* [1]

Material	All papers		Newsprint		Book		Boards		Wrapping		Fine (writing)		All other	
	Percent	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*
New wood pulp:														
Mechanical	12.3	1,654,464	85.2	812,972	1.9	28,670	4.9	298,599	0.7	15,866			23.9	498,357
Sulfite	20.5	2,767,050	14.7	140,276	52.0	797,987	7.8	476,210	22.6	506,029	85.2	506,340	16.4	340,208
Soda	3.6	490,913			29.3	449,962					.5	2,782	1.8	38,169
Sulfate	23.0	3,102,763		50			25.5	1,558,771	65.3	1,461,724	.6	3,607	3.8	78,611
Semichemical	.8	111,971					1.9	111,971						
Total	60.2	8,127,161	99.9	953,298	83.2	1,276,619	40.1	2,445,551	88.6	1,983,619	86.3	512,729	45.9	955,345
Other fibers:														
Waste paper	28.3	3,820,971			8.2	126,379	47.2	2,880,446	6.2	139,120	1.7	10,308	31.9	664,718
Straw	2.8	369,355					6.0	368,619		736				
Rags	2.8	382,994			.2	2,491	.1	6,337			6.1	36,438	16.2	337,728
Manila fiber	.4	57,000					.1	6,862	2.3	50,138				
All other	.7	100,201				47	.6	37,085	.5	11,234	.1	843	2.5	50,992
Total	35.0	4,730,521			8.4	128,917	54.0	3,299,349	9.0	201,228	7.9	47,589	50.6	1,053,438
Nonfibrous:														
Clay	2.3	302,994	.1	684	3.9	60,456	2.8	167,957	.5	10,012	4.3	25,580	1.8	38,305
Rosin	.2	32,323			.5	8,403	.3	20,886	.1	3,034				
Rosin size	.5	70,744		277	.5	7,290	.4	25,354	.8	17,861	.6	3,310	.8	16,652
Casein	.1	14,949			.1	1,315	.2	13,027						607
All other	1.7	230,950			3.4	51,591	2.2	132,844	1.0	23,239	.9	5,386	.9	17,890
Total	4.8	651,960	.1	961	8.4	129,055	5.9	360,068	2.4	54.146	5.8	34,276	3.5	73,454
Grand total	100.0	13,509,642	100.0	954,259	100.0	1,534,591	100.0	6,104,968	100.0	2,238,993	100.0	594,594	100.0	2,082,237

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[1] Grand total quantities shown (in tons of 2,000 pounds) are those manufactured in 1939, as reported by the Census of Manufactures. The quantities of component materials tabulated above are estimates from which losses in paper manufacture have been excluded.

Table 7.—*Composition of the cultural papers manufactured in 1939* [1]

Material	Newsprint		Book		Fine (writing)					
					Total		Rag		Sulfite bond and other chemical pulp	
	Percent	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*
New wood pulp:										
Mechanical	85.2	812,972	1.9	28,670						
Sulfite	14.7	140,276	52.0	797,987	85.2	506,340	50.4	42,272	90.9	464,068
Soda			29.3	449,962	.5	2,782			.5	2,782
Sulfate		50			.6	3,607	.8	699	.6	2,908
Semichemical										
Total	99.9	953,298	83.2	1,276,619	86.3	512,729	51.2	42,971	92.0	469,758
Other fibers:										
Waste paper			8.2	126,379	1.7	10,308			2.0	10,308
Straw										
Rags			.2	2,491	6.1	36,438	43.4	36,438		
Manila fiber										
All other				47	.1	843	1.0	843		
Total			8.4	128,917	7.9	47,589	44.4	37,281	2.0	10,308
Nonfibrous:										
Clay	.1	684	3.9	60,456	4.3	25,580	3.8	3,161	4.4	22,419
Rosin			.5	8,403						
Rosin size		277	.5	7,290	.6	3,310	.2	130	.6	3,180
Casein			.1	1,315						
All other			3.4	51,591	.9	5,386	.4	354	1.0	5,032
Total	.1	961	8.4	129,055	5.8	34,276	4.4	3,645	6.0	30,631
Grand total	100.0	954,259	100.0	1,534,591	100.0	594,594	100.0	83,897	100.0	510,697

[1] Grand total for each paper (in tons of 2,000 pounds) is the quantity manufactured in 1939, as reported by the Census of Manufactures. The quantities of component materials tabulated above are estimates from which losses in paper manufacture have been excluded. Cultural papers are those used for printing and writing. It should be observed, however, that certain groundwood printing papers, and also cover and text papers are included in the "All other" (miscellaneous) group, shown in a succeeding table.

TABLE 8.—*Composition of paperboards manufactured in 1939* [1]

Material	Total		Container		Box		Card and bristol		All other	
	Percent	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*
New wood pulp:										
Mechanical	4.9	298,599	1.9	63,741	6.7	150,271			22.3	84,587
Sulfite	7.8	476,210	6.3	211,485	6.4	141,722	35.2	48,722	19.6	74,281
Soda										
Sulfate	25.5	1,558,771	43.2	1,452,629	4.4	98,218			2.1	7,924
Semichemical	1.9	111,971	2.4	80,294					8.3	31,677
Total	40.1	2,445,551	53.8	1,808,149	17.5	390,211	35.2	48,722	52.3	198,469
Other fibers:										
Waste paper	47.2	2,880,446	34.1	1,146,124	68.8	1,529,990	41.5	57,352	38.7	146,980
Straw	6.0	368,619	9.4	317,179	2.3	51,440				
Rags	.1	6,337							1.7	6,337
Manila fiber	.1	6,862			.3	6,862				
All other	.6	37,085	.3	9,595	.6	12,454	1.1	1,592	3.5	13,444
Total	54.0	3,299,349	43.8	1,472,898	72.0	1,600,746	42.6	58,944	43.9	166,761
Nonfibrous:										
Clay	2.8	167,957			6.6	147,351	14.9	20,606		
Rosin	.3	20,886	.4	13,998					1.8	6,888
Rosin size	.4	25,354	.1	1,853	.8	18,068	1.1	1,538	1.0	3,895
Casein	.2	13,027			.5	10,386	1.9	2,641		
All other	2.2	132,844	1.9	64,543	2.6	58,684	4.3	5,897	1.0	3,720
Total	5.9	360,068	2.4	80,394	10.5	234,489	22.2	30,682	3.8	14,503
Grand total	100.0	6,104,968	100.0	3,361,441	100.0	2,225,446	100.0	138,348	100.0	379,733

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[1] Grand total quantities shown (in tons of 2,000 pounds) are those manufactured in 1939, as reported by the Census of Manufactures. The quantities of component materials tabulated above are estimates from which losses in paper manufacture have been excluded.

Table 9.—*Composition of wrapping papers manufactured in 1939* [1]

Material	Total		Unbleached sulfite and semibleached sulfate		Bleached sulfite and bleached sulfate		Kraft wrapping		All other wrapping	
	Percent	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*
New wood pulp:										
Mechanical	0. 7	15, 866							4. 8	15, 866
Sulfite	22. 6	506, 029	49. 3	139, 835	66. 3	228, 729	1. 6	20, 429	35. 5	117, 036
Soda										
Sulfate	65. 3	1, 461, 724	44. 3	125, 769	26. 2	90, 305	94. 5	1, 210, 725	10. 6	34, 925
Semichemical										
Total	88. 6	1, 983, 619	93. 6	265, 604	92. 5	319, 034	96. 1	1, 231, 154	50. 9	167, 827
Other fibers:										
Waste paper	6. 2	139, 120	3. 2	9, 202	2. 6	8, 948	2. 1	26, 947	28. 5	94, 023
Straw		736							. 2	736
Rags										
Manila fiber	2. 3	50, 138							15. 2	50, 138
All other	. 5	11, 234					. 3	4, 208	2. 1	7, 026
Total	9. 0	201, 228	3. 2	9, 202	2. 6	8, 948	2. 4	31, 155	46. 0	151, 923
Nonfibrous:										
Clay	. 5	10, 012			2. 5	8, 539			. 5	1, 473
Rosin	. 1	3, 034					. 1	921	. 7	2, 113
Rosin size	. 8	17, 861	1. 0	2, 745	1. 5	5, 072	. 5	6, 461	1. 1	3, 583
Casein										
All other	1. 0	23, 239	2. 2	6, 119	. 9	3, 164	. 9	11, 343	. 8	2, 613
Total	2. 4	54, 146	3. 2	8, 864	4. 9	16, 775	1. 5	18, 725	3. 1	9, 782
Grand total	100. 0	2, 238, 993	100. 0	283, 670	100. 0	344, 757	100. 0	1, 281, 034	100. 0	329, 532

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[1] Grand total quantities shown (in tons of 2,000 pounds) are those manufactured in 1939, as reported by the Census of Manufactures. The quantities of component materials tabulated above are estimates from which losses in paper manufacture have been excluded.

TABLE 10.—*Composition of all other (miscellaneous) papers manufactured in 1939* [1]

Material	Total		Groundwood printing and specialty		Cover and text		Tissue		Absorbent		Building		All other	
	Percent	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*
New wood pulp:														
Mechanical	23. 9	498, 357	61. 3	331, 115	5. 1	1, 615	21. 4	142, 144	0. 9	1, 088	0. 2	1, 355	33. 1	21, 040
Sulphite	16. 4	340, 208	28. 4	153, 711	71. 4	22, 668	17. 0	112, 996	22. 1	26, 954	1. 0	6, 828	26. 8	17, 051
Soda	1. 8	38, 169			5. 0	1, 581	. 3	1, 979	27. 4	33, 354	. 2	1, 255		
Sulfate	3. 8	78, 611					10. 9	72, 658					9. 3	5, 953
Semichemical														
Total	45. 9	955, 345	89. 7	484, 826	81. 5	25, 864	49. 6	329, 777	50. 4	61, 396	1. 4	9, 438	69. 2	44, 044
Other fibers:														
Waste paper	31. 9	664, 718	3. 3	17, 657	4. 4	1, 394	49. 2	327, 790			47. 3	311, 776	9. 6	6, 101
Straw														
Rags	16. 2	337, 728			4. 2	1, 331			40. 8	49, 649	43. 5	286, 748		
Manila fiber														
All other	2. 5	50, 992					. 3	2, 357	8. 7	10, 563	5. 8	38, 072		
Total	50. 6	1, 053, 438	3. 3	17, 657	8. 6	2, 725	49. 5	330, 147	49. 5	60, 212	96. 6	636, 596	9. 6	6, 101
Nonfibrous:														
Clay	1. 8	38, 305	3. 5	18, 928	7. 2	2, 295	0. 1	537			1. 0	6, 688	15. 5	9, 857
Rosin														
Rosin size	. 8	16, 652	1. 9	10, 341			. 6	4, 184	. 1	101	. 2	1, 411	1. 0	615
Casein		607											. 9	607
All other	. 9	17, 890	1. 6	8 590	2. 7	856	. 2	1, 078		8	. 8	4, 957	3. 8	2, 401
Total	3. 5	73, 454	7. 0	37, 859	9. 9	3, 151	. 9	5, 799	. 1	109	2. 0	13, 056	21. 2	13, 480
Grand total	100. 0	2, 082, 237	100. 0	540, 342	100. 0	31, 740	100. 0	665, 723	100. 0	121, 717	100. 0	659, 090	100. 0	63, 625

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[1] Grand total quantities shown (in tons of 2,000 pounds) are those manufactured in 1939, as reported by the Census of Manufactures. The quantities of component materials tabulated above are estimates from which losses in paper manufacture have been excluded.

The trend of wood-fiber use in paper making is indicated in table 11, showing the residuals of new pulp and reused paper for the census years up to 1939. In 1879 the small amount of new wood pulp used (less than 5 percent) explains the very low figure for wood pulp in reused paper. The relatively small furnish of new pulp in 1929 is probably due to the decrease in the production of newsprint, which is approximately 100 percent new wood pulp. It is probable that the percent of all wood pulp in paper, which reached 88.5 in 1939, will never go beyond 90.

TABLE 11.—*Estimated tonnage and percent of new and reused wood pulps in paper manufactured, 1879–1939* [1]

Year	Wood fiber retained in paper			Pulp percentages of paper		
	New wood pulp	From reused paper	Total	New wood pulp	From reused paper	Total
	1,000 tons	*1,000 tons*	*1,000 tons*	*Percent*	*Percent*	*Percent*
1879	21	4	25	4.6	0.9	5.5
1889	318	39	357	34.0	4.2	38.2
1899	1,079	173	1,252	49.7	8.0	57.7
1909	2,606	605	3,211	61.8	14.3	76.1
1919	3,726	1,155	4,881	60.2	18.7	78.9
1929	6,047	3,424	9,471	54.3	30.7	85.0
1939	8,127	3,821	11,948	60.2	28.3	88.5

[1] Tons of 2,000 pounds.

CONVERSION FACTORS

From tables 6 to 10 are drawn the factors converting papers to wood pulps and wood pulps to papers, as shown in tables 12 and 13. These factors will vary as conditions in the industry change the furnish for various papers.

The Census of Manufactures reports annually the number of cords of pulpwood consumed in each pulping process, and the tons of wood pulp and screenings produced. The conversion factors between wood and wood pulp derived from these reports (table 14) combine all kinds of pulpwood used in each process and for that reason may not apply closely in cases where individual species only are involved.

TABLE 12.—*Wood pulp equivalents of each kind of paper, 1939* [1]

[In percent of paper tonnages]

Wood pulps (new)	Kinds of paper						
	Newsprint	Book	Boards	Wrapping	Fine	All other	All paper
Mechanical	90.0	2.0	5.2	0.7		25.3	12.9
Sulfite	15.5	54.7	8.2	23.8	89.6	17.2	21.6
Soda		30.8			.5	1.9	3.8
Sulfate	.0		27.6	70.6	.7	4.1	24.8
Semichemical			1.9				.9
All pulps	105.5	87.5	42.9	95.1	90.8	48.5	64.0

[1] These percents are estimated national averages of the "furnish" of each kind of pulp to each kind of paper. They include the losses in manufacture. They are for use in conversion of paper tonnages to the pulps required to make them. For example, the mechanical pulp required to make newsprint is 90.0 percent of the newsprint tonnage. The loss of mechanical pulp in this process is 4.8 percent of the newsprint tonnage manufactured, in which the mechanical component is 85.2 percent.

TABLE 13.—*Paper equivalents of each kind of wood pulp, 1939* [1]

[In percent of wood-pulp tonnages]

Wood pulps (new)	Kinds of paper						
	Newsprint	Book	Boards	Wrapping	Fine	All other	All paper
Mechanical	49.1	1.7	18.1	1.0		30.1	100.0
Sulfite	5.1	28.8	17.2	18.3	18.3	12.3	100.0
Soda		91.6			.6	7.8	100.0
Sulfate	.0		50.3	47.1	.1	2.5	100.0
Semichemical			100.0				100.0
All pulps	11.6	15.5	30.3	24.6	6.3	11.7	100.0

[1] Includes losses in paper manufacture. These percents are for use in conversion of wood-pulp tonnages to equivalent paper tonnages. For example, 49.1 percent of the mechanical pulp used for paper goes into newsprint. The loss in this process is 2.7 percent of the mechanical pulp used. The loss of mechanical pulp in all processes is 5.4 percent.

TABLE 14.—*Factors converting wood pulp to pulpwood, and vice versa*

Process	Cords per ton of wood pulp		Tons [2] of pulp per cord of wood	
	3-year average [1]	1939	3-year average [1]	1939
	Cords	*Cords*	*Tons*	*Tons*
Mechanical	0.91	0.91	1.10	1.10
Sulfite	1.88	1.87	.53	.54
Soda	1.77	1.73	.56	.58
Sulfate	1.62	1.63	.62	.61
Semichemical	1.25	1.24	.80	.81
All processes	1.55	1.55	.65	.65

[1] Averages of 1938, 1939, and 1940. For general use, not confined to a specific year, the 3-year averages are preferable. Canada factors for mechanical and sulfite pulp agree closely with the United States averages for 1939. Screenings were included with pulps of the same kind.

[2] Tons of 2,000 pounds.

HOW FIBER REQUIREMENTS HAVE BEEN MET AT HOME

BY EXPANSION OF THE SULFATE INDUSTRY

For the strong, light, inexpensive packing material essential to modern industrial life, such as wrapping, bags, cartons, and building boards, sulfate pulp is unrivaled. The enormous demand for it has been met by the phenomenal expansion of the sulfate-pulp industry, which produced 2,963,100 tons in 1939, and 3,725,000 tons in 1940, as against 53,000 tons in 1914. In 1914 more than half the sulfate pulp used was imported; in 1939, some 390,000 tons. By 1940 the industry was practically self-sustaining and sulfate is now the foremost wood pulp.

Abnormal increases in the requirements for both bleached and unbleached sulfate pulp took place during 1941, largely because of the enormous demand for packing material for lend-lease articles shipped abroad. The second World War also cut off European sources of paper and pulp. By the end of 1941 merchants were no longer giving away kraft bags and the Government was asking the public to salvage used cartons and other papers for reuse in boards. The sulfate mills, and others as well, were working at full capacity. But the boards and other papers shipped abroad do not come back to American mills for reuse.

By Utilization of Waste Paper

With the possible exception of sulfate-pulp sources, the material offering the largest reserve of wood-pulp supply is waste paper. That is true both on account of the quantity of material available and the considerable percent of wood pulp which it contains. As indicated in figure 2, that content, which was in the neighborhood of 40 percent in 1889, had risen to about 88 percent in 1939. In other words, as time has elapsed, a larger quantity of pulp has become available from each ton of paper reused.

Hence, although between 1919 and 1939 the quantity of paper reused by the paper industry was more than doubled, there was no significant increase in the ratio of the waste paper used to total paper produced. Pulp from reused paper in 1939 was 28 percent of the tonnage of all paper made. As shown in table 6, it appears as 47 percent of boards and 32 percent of "all other" (miscellaneous) papers. Ten percent more in boards and 5 percent more in miscellaneous papers would have amounted to 700,000 tons of pulp for which no additional pulpwood need be cut. But important considerations in all such estimates are the ability of certain classes of mills to assimilate more pulp of this kind without deterioration of their product, and the availability, in terms of collection and transportation, of greater quantities of waste paper of usable kinds. These factors controlled the temporary fading-out of the paper-conservation campaign in 1942.

In the absence of reliable reports, the quantity of waste paper available can only be guessed very roughly. Judging from conditions in 1939, somewhat less than 30 percent of the paper tonnage manufactured in 1 year is ordinarily reclaimed by reuse in the following year. Somewhat more than 30 percent goes into more or less permanent use in libraries, in office files, and in building construction. That would leave something like 40 percent for destruction after a single ephemeral use.

Much of this "loss," however, is neither useless waste nor preventable. Part of the paper classed as destroyed kindles fires or is put to other good use in million of homes. Another part is of such composition or so soiled that reuse in paper manufacture is not feasible. A third, and possibly a larger part, is scattered so widely, not only in rural regions but also in cities and towns remote from mills, that the cost of assembling it has seemed too great for profitable utilization. Possibly 1,000,000 tons of paper which could be assembled and reused is burned annually as trash.

Taking into account the losses in manufacture, pulp from waste paper was in 1939 about as costly as semichemical pulp. The only cheaper fiber in the list of materials was straw. The field of usefulness of waste-paper pulp is, however, far wider than that of either semichemical or straw pulp. The enormous quantity already utilized is proof of the dependence upon it of the manufacturers of boards and, in fact, of all other principal classes of papers except newsprint.

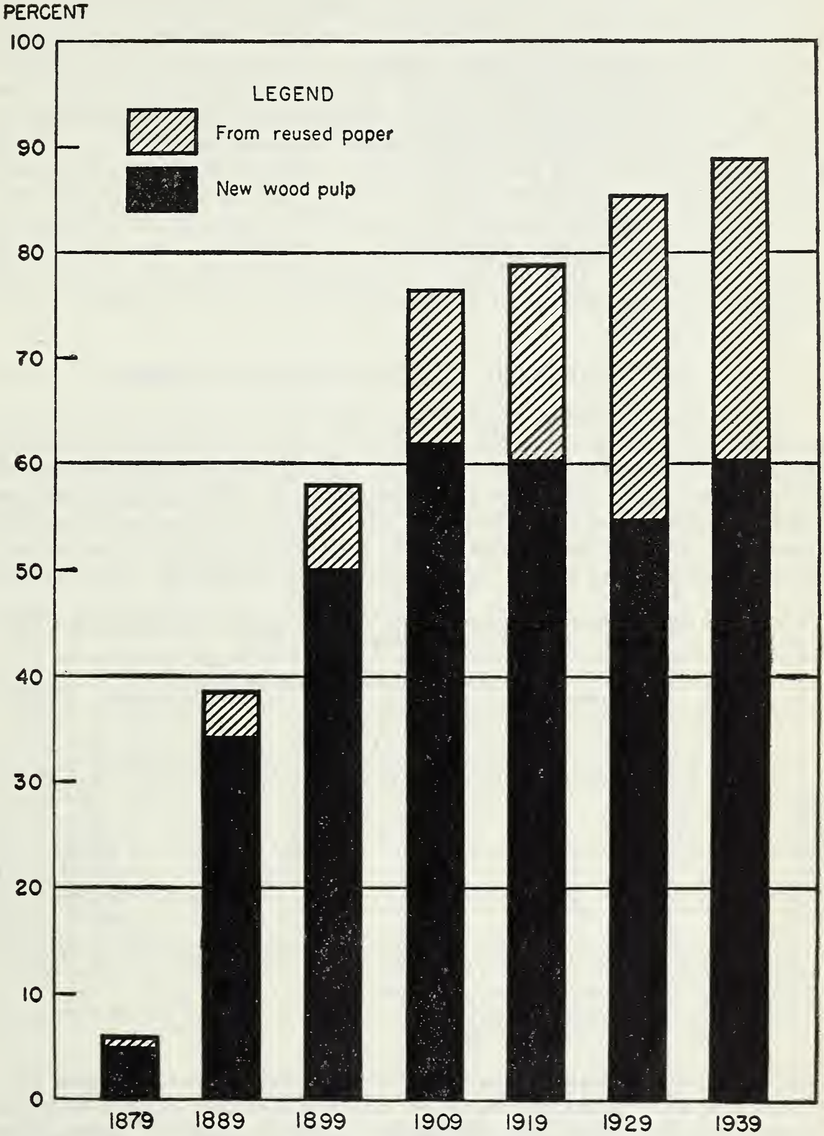

FIGURE 2.—Percent of new and reused pulps in paper, 1879–1939.

By Economies in Pulping Processes

Naturally, pulp manufacturers are taking steps which increase the production of pulp from wood, decrease waste, and tend to keep prices down. The recorded loss of 30 percent of materials in paper manufacture in 1879 has been greatly reduced by improved processes. Figures from the Census of Manufactures reflect successful economies of this kind during the decade 1930–39. From the average cord of wood the mechanical mills get 91 pounds of pulp more than previously, the sulfite mills 55 pounds, and the sulfate mills 134 pounds. Soda and semichemical averages also show savings. The average gain for all pulps is 93 pounds per cord. These changes result principally from the abandonment of some pulp mills of old design, the introduction of modern machinery, and the application of improved techniques both in the preparation of pulpwood, the subsequent pulping processes, and salvage. According to Census reports, the quantity of screenings per ton of pulp produced has decreased by 50 percent since 1929.

DEPENDENCE UPON FOREIGN FIBER

As indicated in table 15, the United States has been heavily dependent for wood fiber on the forests of foreign countries, particularly those of Canada and northern Europe. That situation arose primarily from the selective nature of the requirements. The industry wanted chiefly mechanical and sulfite pulps, which could best be made from the spruce, fir, and hemlock timber of the northern forests, and in country where ample water power for grinding was available. That meant northern New England, New York, Pennsylvania, and later the Lake States and the Pacific Northwest.[1] The northeastern forests had been heavily cut for white pine, and later for spruce lumber. Since most of eastern Canada had forests of the type desired, it was very natural that large quantities of fiber in the form either of pulpwood, wood pulp, or paper should be drawn from that source. The growing domestic requirement was also supplemented by increasing imports of pulp and paper from the mills of northern European countries.

TABLE 15.—*Source of wood-pulp requirement,[1] in terms of pulpwood, annually by decennial years, 1869–1939, 1940*

Year	Domestic pulpwood	Imported pulpwood, wood pulp and paper			Total requirement	Foreign component
		Canada	All other [2]	Total		
	1,000 cords	*1,000 cords*	*1,000 cords*	*1,000 cords*	*1,000 cords*	*Percent*
1869	2				2	
1879	41				41	
1889	583	[3] 80		[3] 80	663	12
1899	1,617	420	38	458	2,075	22
1909	3,208	1,025	337	1,362	4,570	30
1919	4,339	2,741	239	2,980	7,319	41
1929	6,396	5,477	2,288	7,765	14,161	55
1939	[4] 9,712	4,689	2,790	7,479	17,191	44
1940	[5] 12,372	5,804	745	6,549	18,921	35

[1] Requirement includes domestic consumption of paper, plus exports of wood pulp and paper. Pulpwood exports are negligible.
[2] Practically all Norway, Sweden, Finland, and Germany.
[3] Estimated.
[4] Includes about 2 percent of imported wood.
[5] Includes a small quantity of imported wood.

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[1] In 1939 the Pacific Northwest used 21 percent of the pulpwood consumed in the United States. The importance of this region as a producer of sulfite pulp is also rapidly increasing.

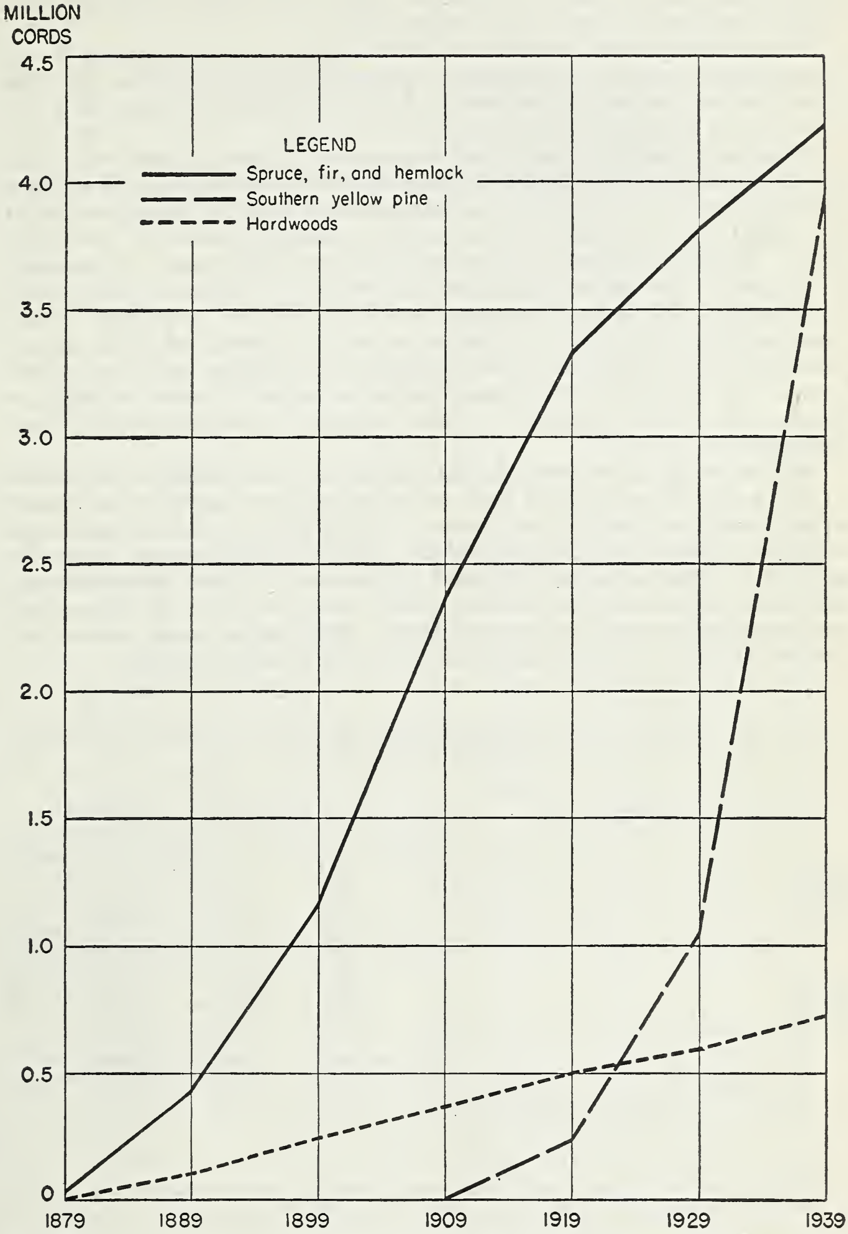

FIGURE 3.—Principal kinds of domestic pulpwood consumed annually, by decennial years, 1879–1939.

Until the decade 1920–29 more sulfate pulp was imported from Canada and Norway combined than was manufactured at home. After that, production of domestic sulfate increased phenomenally and far outstripped imports of sulfate fiber.

From 1921 to 1936 more than half the American requirement for all wood fibers was met by imports, principally because that was the cheapest way to get it, but partly because American forests had not been wisely managed and utilized.

Supplementing the preceding statements, figure 3 illustrates the chief demand of the domestic pulp industry throughout the years upon pulpwood from the spruce-fir-hemlock type of forest and also the rapid recent growth of the sulfate industry, based on southern pine. All of the latter is, of course, domestic pulpwood. If account is taken of the large additional quantities of imported pulpwood, wood pulp, and paper consumed in the past, the true size of the past requirement appears. The pulpwood equivalent of all the paper consumed since 1869 is in round figures 350 million cords, of which more than 40 percent was imported in the form of wood, or pulp, or paper. About 70 percent of the imported material came from Canada.

As the result of the considerable dependence on foreign wood fiber in the past, the aggregate drain which the paper industry has made upon forests of the United States is strikingly small in comparison with the values realized therefrom. From 1860 through 1939 the aggregate drain on domestic wood (80 percent of total requirements) has been only about 237 million cords (table 16), over 93 percent of which has been consumed since 1900. Within the same period the volume of the fuel wood burned has been 40 times as great.

Table 16.—*Domestic and foreign pulpwood consumed in the United States, by decades, 1860–1939*

Decade	Total	Domestic	Imported	
	1,000 cords	*1,000 cords*	*1,000 cords*	*Percent*
1860–69	15	15		
1870–79	215	215		
1880–89	3,120	3,120		
1890–99	12,845	11,000	1,845	14
Total	16,195	14,350	1,845	11
1900–09	30,758	24,601	6,157	20
1910–19	47,981	39,248	8,733	18
1920–29	62,277	50,780	11,497	18
1930–39	79,678	70,598	9,080	11
Total	220,694	185,227	35,467	16
Grand total	236,889	199,577	37,312	16

OUTLOOK FOR THE FUTURE

Although more than 40 percent of the total volume of timber standing in the United States, amounting to 2 billion cords, is of species now commonly used in the manufacture of wood pulp, only a small part of this is physically and economically available for wood-pulp production. Under present conditions, it is not as available as some of the foreign supply, such as the spruce-fir-hemlock of Canada.

The paper requirement of the United States is increasing, especially under the stimulus of war conditions. Part of the post-war requirement will continue to be met by imports, certainly from Canada and possibly from North Europe.

Whether or not commercial relations with northern Europe are resumed, there is every reason to expect an increased pulpwood drain upon the forests of the United States, especially those of the South and the Pacific Northwest. In view of the great quantity of suitable timber, there is no apparent reason why this requirement cannot be met, provided the drain is adjusted to the resource.

Continued research in the utilization of certain species may be expected to increase the available supply. Increased integration with lumber operations will produce paper from otherwise useless waste. The allocation of pulpwood to the most urgent needs will prevent dislocations due to the stresses of war. But in the long run the proper management of forest lands will be found the foremost means of maintaining an enduring and satisfactory economy.

In broad terms it may be said that the United States is self-sufficient in pulpwood for sulfate and soda pulps. Not so, however, in regard to the important sulfite and mechanical pulps. The spruce, fir, and hemlock trees from which these pulps are made grow in the great northern forests along the Canadian boundary and on the North Pacific coast. Something like 70 percent of the readily available pulpwood of this kind is in Canada. About 80 percent of the Canadian resource of this timber is in the eastern Provinces, Ontario, Quebec, New Brunswick, and Nova Scotia. The same forests extend south of the boundary into the Lake States, the Middle Atlantic States, and New England. It is in these States and Provinces that the greatest concentrations of pulp mills are located, drawn there first by the combination of spruce timber with available water power and by proximity to the richest markets in the world. They supply about four-fifths of our newsprint, in addition to other indispensable papers made of ground wood and sulfite.

To this considerable extent the United States is dependent upon the forests of Canada. The eastern forests of both countries are overcut, but their utilization has been mutually advantageous. It seems improbable that the situation will change materially, except that the shift of economic conditions will probably bring about a greater utilization of the hemlock, spruce, and fir in the Pacific Northwest. Harmonious cooperation between the United States and Canada will assure sufficiency of pulps of all kinds in North America.

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